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Development of Standard Times for Work Modules Used in Quantity Food Production

Nadine E. Smith
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Nadine E. Smith entitled "Development of Standard Times for Work Modules Used in Quantity Food Production." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

Mary J. Hitchcock, Major Professor

We have read this thesis and recommend its acceptance:

Grayce E. Goertz, John N. Snider

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Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

February 24, 1972

To the Graduate Council:

I am submitting herewith a thesis written by Nadine E. Smith entitled "Development of Standard Times for Work Modules Used in Quantity Food Production." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Institutional Administration.

Mary J. Hitchcock
Major Professor

We have read this thesis and recommend its acceptance:

Grayce E. Goertz

John N. Lowin

Accepted for the Council:

Stetson A. Smith
Vice Chancellor for
Graduate Studies and Research

DEVELOPMENT OF STANDARD TIMES FOR WORK MODULES USED IN QUANTITY FOOD PRODUCTION

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Nadine E. Smith

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ABSTRACT

Reduction of costs and continuous cost control is a necessary element in modern food service industries. This study explored the application of time and motion techniques to the production of roast beef sandwiches in volume to establish standard times. For this purpose each specific task was divided into work elements whose beginning and ending points were easily recognized. Continuous stop-watch timing was used for the data collection of work performed by one person.

Standard times were determined for each element and each task. Sequential time data were plotted graphically to illustrate the learning curve demonstrated in representative work elements. A 95 percent confidence interval was used as the basis for determination of standard times for each element. Through the additivity of the elemental times, total task time of 0.18 minutes was established for placing and adjusting roast beef for slicing; 1.26 minutes for cleaning a head of lettuce; and 9.58 minutes for assembling twenty-four roast beef sandwiches.

Using the elemental times determined in this study, it could be possible for managers to evaluate present and proposed work methods, standardize procedures and techniques, predict production times, and effectively schedule personnel and equipment.

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CHAPTER I

INTRODUCTION

Measurement and control of costs is essential for the survival of any business. Controls will be no better than the measurements upon which they are based and without some kind of measure, control is impossible (Crossen and Nance, 1962).

Time and motion studies are a means of analyzing and specifying work measurement which promote analysis of the operation. An analysis of an operation by its elements can be accomplished in such a way that it serves to point up the major elements of production time and deflections such as delay. Study of these elements may serve as a guide for production improvement (Christensen, 1958).

Time studies are the basis for effective measurement of employee and departmental job performance and may become a major part of cost control. If a proper accounting is kept of certain elements in a standard, much valuable information can be obtained to afford corrective measures or to afford a true measurement of the job efficiency.

Time standards can serve as a means for standardizing procedures and techniques used in food production (Brown, 1969). Man-hour requirements for menus can be predicted and stated as the daily man-hour requirements for each production unit. Standard time data for food production serves as a management tool to aid in forecasting, controlling, and evaluating labor requirements.

Professionals interested in the study of human behavior have recognized that learning is time dependent (Niebel, 1972). Simple operations may take hours to master and complicated work may take weeks before the operator can achieve a skillful, coordinated mastery of the task.

If a person can perform a manual task, he can, with practice, reduce the time required per cycle (Barnes, 1968). The shape of the learning curve will be affected by the type of work and by the habits, abilities, and attitude of the individual performing the task. "The theory of the learning curve proposed that, as the total quantity of units produced doubles, the time per unit declines at some constant percentage."[1] When the worker reaches the flattening section of the learning curve, the problem of performance rating is simplified.

During the time study the analyst must evaluate the speed at which the operator is working (Barnes, 1968). This is called rating and is a comparison of the observer's own concept of normal performance. The most widely used system of rating in this country is called "performance rating" in which only the operator's speed is rated, with normal performance being equal to 100 percent. Niebel, 1972, stated that there is no one universal method of performance rating and no one universal concept of normal performance. Judgment is the criterion for the determination of the rating factor. In order to establish a true standard time, an allowance must be added to the normal time to take care of slowdowns,

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[1]B. W. Niebel, Motion and Time Study (fifth edition; Homewood, Ill.: Richard D. Irwin, Inc., 1972).

interruptions and delays brought on by fatigue. The fatigue allowance can be handled through the establishment of periodic rest periods.

The most difficult responsibility of management is the effective utilization of human resources (Milijies, 1970). It is the manager's task to effectively allocate and utilize scarce and costly resources, such as time and labor, in order to achieve a variety of broad objectives.

The purpose of this study was to develop a standard time for selected elements involved in the task of making roast beef sandwiches.

CHAPTER II

REVIEW OF LITERATURE

I. WORK MEASUREMENT

Work measurement (Stukey, 1964) is becoming an essential ingredient in assigning a time dimension for designing products, machinery, and tooling; determining the best manufacturing procedure; designing plant layout, scheduling production, and optimizing inventory layouts. By having concrete information as to the required volume of production as well as the time required to produce a unit of that production, it is possible to determine the required labor force (Niebel, 1972).

Industrial engineering studies indicate employees in food service work at about 40-50 percent efficiency, tending to adjust the amount of work done by speeding up or slowing down according to demand (Blaker, 1970). Variations in the work load (Pomeroy, 1967) often present problems in a methods measurement installation because these variations make it difficult for management to keep staffing levels adjusted to the number of personnel required to handle the work efficiently at any given time.

Many advances are being made in work measurement in industrial plants that can be applied to food service operations (Flack, 1965). It is important to build flexibility into food facilities and operations so that these advances may be incorporated into existing facilities when they become available.

There are two basic methods of assigning tasks in food service (Blaker, 1970). The vertical plan constitutes work divided among

individuals with each individual being responsible for the preparation of certain items from start to finish, including the cleaning of work areas and equipment. Horizontal or assembly line work is divided into steps, with different individuals being responsible for certain steps in the preparation of all items. The trend today is toward the horizontal method which could make efficient use of standard elemental times.

II. TIME STANDARDS

Time standards are usually based on historical records, time study, work sampling, predetermined motion time data, or elemental data. These standards may be used as a basis for wage incentive plans and labor cost control, planning and scheduling work, making cost estimations, and for preparing budgets (Aquilano, 1968).

As in industry (Kent, et al., 1965), increased production in food service could result from increased utilization of personnel, equipment, space, materials, and more efficient manipulation of the variables of capital and time which control the interdependent resources. In food production areas, the need for qualitative and quantitative standards for comparison, evaluation, and control of productivity is apparent. Time standards (Krick, 1966) are basically used for planning and evaluation and are indispensable to the successful operation of an organization involved in production.

Montag, et al. (1964) investigated the feasibility of using predetermined motion times to enable management to predict labor times which could be used to achieve better utilization of food service personnel. M.S.D. (Master Standard Data) was the predetermined

motion-time system used to investigate the production of eight portions of baked pudding and sixteen dozen yeast rolls.

The techniques used to determine production times were:

(a) complete analysis of the motion pattern using M.S.D;

(b) use of coded standard data elements built from M.S.D.

Stop-watch check studies were made for comparison of M.S.D. times.

Production times established from predetermined motion times tended to be more accurate than those derived from time study. The use of M.S.D., when built into coded standard data elements and the coded time applied to the preparation of a given product, was found to be effective for developing estimates of labor times for certain food production tasks.

M.T.M. (Methods Time Measurement) and stop-watch time study were used by Beach, et al. (1969) to evaluate the feasibility of predetermined motion-time techniques to accurately determine performance times for elements of entree serving cycles. Four serving elements were determined using M.T.M. Six entree serving cycle groups, based on the element time, were established. The mean stop-watch serving time of the individual entrees in each group was compared with the M.T.M. serving time derived by adding the element values composing the serving cycle for the entrees in the group.

For the entree serving cycle group, the sum of the M.T.M. mean element times composing each serving cycle were equivalent to the mean stop-watch time for all items in each group. This indicated that predetermined motion times could be used to accurately determine performance time for elements of entree serving cycles.

The objective of research conducted by Ivancky, et al. (1969) at the Cleveland Metropolitan General Hospital were to: (a) determine time relationships involved in preparing different amounts of a given recipe, (b) predict the time needed to prepare any other quantity of a recipe that had been timed, (c) to predict the time required to prepare any recipe that had not been studied.

It was projected that the computer would print the following pertinent information to be used by the cooks: recipe formulae in the amounts required, equipment required and chronological time of production correlated with food production directions. The project was limited to preparations, panning, and cooking time for fifteen selected recipes in five different amounts. The assembly time was not included in the study. Dietitians observed the recipes being produced, the number of cooks required, the equipment used and the steps followed. The information gathered was analyzed and procedures and equipment were standardized for timing the recipes.

Each recipe was divided into elements--in this case an element was the smallest direction in a recipe indicating action. Each element or step was timed to the nearest 0.05 of a minute. The time data obtained were analyzed mathematically with the aid of a computer. Since the recipes were divided into elements, it should be possible to predict the time required to produce a recipe that had not been timed.

Brown (1969) approached the problem of measuring standard recipe times through the development of "modules." Many tasks or steps were repeated in different recipes and one standard measurement of labor,

called a "module," was established for each task. It was concluded that labor costs for recipes not studied could be predicted by suitable arrangement of existing modules, but recipes containing new steps must be studied to identify modules and standard times for the steps not analyzed previously.

Labor time standards were developed through time studies of food preparation functions. The times did not include an allowance for lag time but did include detailed data for tasks, movements, distance traveled, batch sizes, and raw ingredients. Time study results were plotted against the appropriate variable for each module. The best fitting curve was found and it became the standard data curve for each module. When a large sampling of observations showed consistent times, the standard time was determined by arithmetical average.

Waldvogel (1967) tested the reliability of a developed element code and associated M.S.D. values when applied to long cycle production of one hundred portions of a complete product. Three single item entree recipes were selected to compare the production time values obtained from application of the alpha-mnemonic code and stop-watch studies. The quantity food production standard time data code developed in this study could serve as a structural framework for the establishment of a code applicable to all aspects of food production.

III. STANDARD ELEMENTAL TIMES

Stukey (1964) predicted that by 1980, standard elemental data will provide the manual method and time values for almost any common element

of work. The elements will be designed so that they can be combined into motion patterns to fit any circumstance. Improved facility in predicting the time required to perform work will make possible a more precise and optimized scheduling of production.

Work cycles may be divided into moderately short phases of activity called elements (Krick, 1966). Nanda (1968) investigated the additivity of elemental times. The experiment was performed by right-handed males between the ages of 18 to 21. None were engineering majors and all were paid $1.50 per hour for participating in the experiment. A minimum of 200 work cycles with an average of 275 was performed for each experimental sequence.

It was concluded that from the operational point of view, the assumptions of unique, independent, and additive mean elemental times are valid. The additional measure of elements would make a significant contribution to solving problems of production, planning, and control and development of more realistic models for systems analysis.

Time standards serve as a means for standardizing procedures and techniques used in food production (Brown, 1969). With detailed standard data, it is possible for management to carefully synthesize the total production time by fitting together the various detailed work elements. Work elements also serve as the best way to evaluate present and proposed work methods (Cloud, 1961).

Present investigations have demonstrated that standard elemental times can be a useful tool in the food production areas. This time study was undertaken to establish standard elemental times for the task of preparing roast beef sandwiches. The comparison of established standard

times with actual times in an operation will facilitate analysis of existing work methods and delays during production. Optimum scheduling of personnel and production could be achieved through the use of standard times.

CHAPTER III

PROCEDURE

The production of roast beef sandwiches was selected for establishing standard elemental times. For the purpose of developing elemental times the production of roast beef sandwiches in units of twenty-four included the tasks of slicing the meat, cleaning lettuce, and assembling the sandwiches. Each task of preparation was divided into elements and each element was timed under similar conditions using the continuous method of stop-watch timing (see Appendix A).

The experiment was performed in the quantity foods laboratory in the Department of Food Science and Institution Administration and the Student Center Cafeteria at The University of Tennessee, Knoxville. The same worker was employed to perform all phases in the production of the sandwiches for each observation. A registered dietitian (analyst) collected the time data for each experiment.

Beef rounds of US Good or US Choice, and in a range of 18 to 22 pounds raw weight, were selected for use. The meat was roasted at 350°F in a conventional electric bake oven until an internal temperature of 160°F was reached. The cooked beef was cooled, the outside fat trimmed, and refrigerated overnight before slicing.

Iceberg lettuce packed twenty-four heads to a carton was used. Hamburger buns packed twelve (net weight 24 ounces, baked) to a package and presliced were used for making the sandwiches. Melted oleomargarine was spread on the buns with a brush measuring one-half inch in width.

I. DESIGN OF STUDY

Task One. Placing and Adjusting Roast Beef for Slicing

Figure 1 shows the arrangement of the work area for slicing roast beef.

Figure 1. Arrangement of the work area.

The table on which the slicer was located was made of stainless steel and measured 72" x 30" x 34". Beef rounds averaging between 16 and 20 pounds cooked weight were thinly sliced on a Hobart slicer, model 1712. A setting of from 5 to 15 was used on the slicer dial to obtain a chipped-type slice of meat.

A data sheet (Appendix A) was used for timing the following elements:

(1) Place beef on slicer carriage.

(2) Tighten holder.

(3) Place top plate down on roast.

(4) Adjust dial and start machine.

Task Two. Cleaning Lettuce

Figure 2 shows the arrangement of the work area for cleaning lettuce.

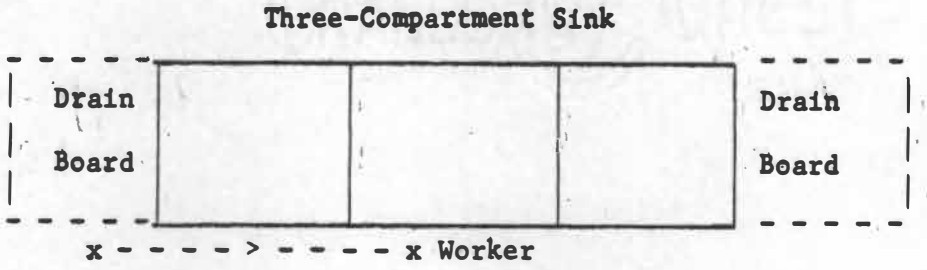

Figure 2. Work area for cleaning lettuce.

The equipment used by the worker to clean lettuce was the three-compartment sink with running water and drainboards.

The worker removed the lettuce core by hitting the core on the drainboard. She moved to the right and washed the head of lettuce in water, moved again to the right and separated the leaves which were allowed to drain in the middle compartment.

The data sheet (Appendix A) for this operation included the timing of the following elements:

(1) Remove core by hitting lettuce against drainboard.

(2) Wash in water to clean head.

(3) Separate leaves.

Task Three. Assembling of Roast Beef Sandwiches

Figure 3 shows the arrangement of the work area for assembling roast beef sandwiches.

The work table used was made of a stainless steel frame with a wooden top and measured 72" x 30" x 35-1/2". It had a bottom shelf of 66" x 24" x 10". Additional rolls were placed on the bottom shelf to eliminate walking on the part of the worker. To facilitate the work area, the tops of buns were placed on a surface behind the worker which she could

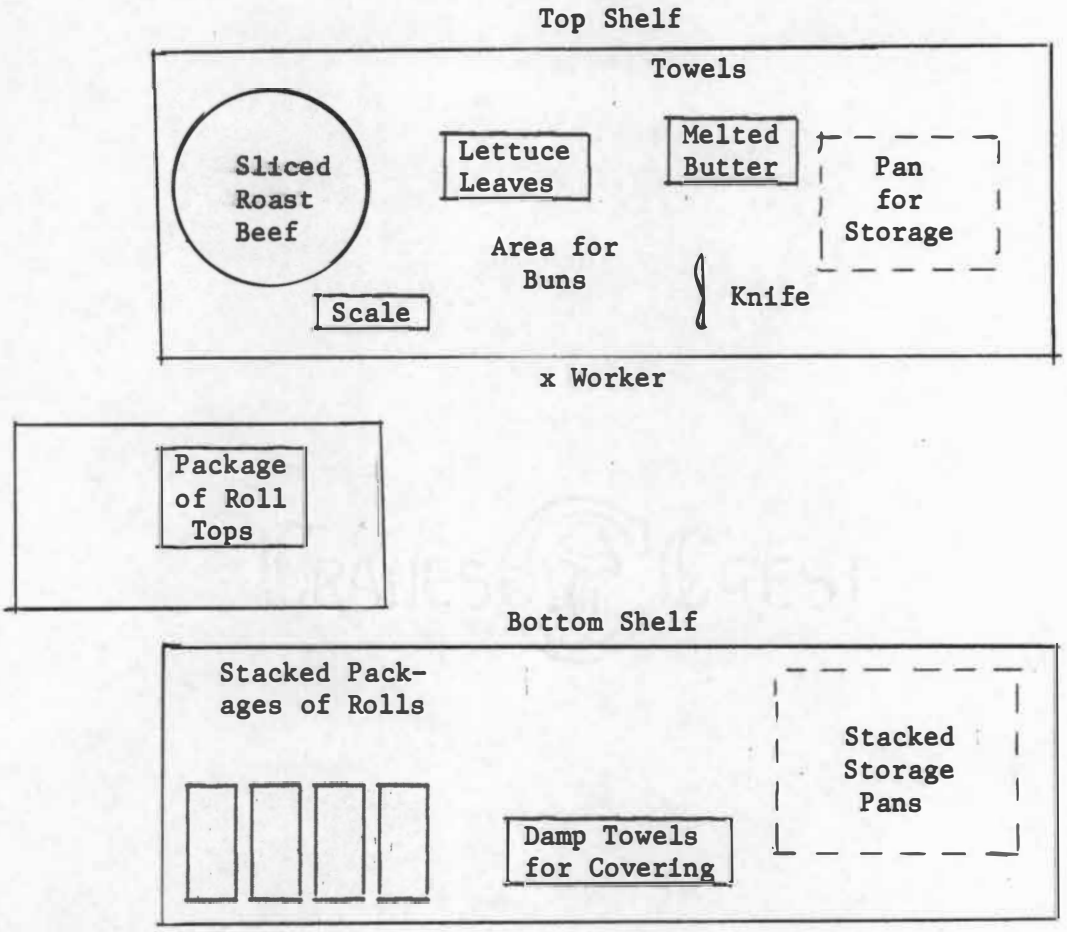

Figure 3. Work area for assembling sandwiches.

reach by pivoting. All areas of the work table were within a comfortable reach span by the worker who assisted with this study.

In addition to the work table, the equipment used by the worker to perform the operation included rolls, melted oleomargarine and brush for spreading, cleaned lettuce torn into appropriate size pieces, chipped beef, cutting knife, damp towels for covering, and pans for storage.

The data sheet (Appendix A) for assembling roast beef sandwiches was used to time the following elements:

(1) Open two packages of rolls.

(2) Place 24 bottom halves on table.

(3) Brush each half with melted oleomargarine.

(4) Weigh and place 2-1/2 ounces of chipped beef on roll.

(5) Top with lettuce leaf.

(6) Top with upper half of roll.

(7) Cut in half and place in pan.

(8) Cover sandwiches with a damp towel.

To conduct the study the observer used a data sheet (Appendix A) for recording time elements and a decimal-minute watch to measure time.

II. COLLECTION AND ANALYSIS OF DATA

A pilot study was conducted prior to the actual experiment which familiarized the analyst with the mechanics of time study. A unit of 24 sandwiches produced four times was made initially to train the worker. The worker was inexperienced when the study began and her speed did increase as the research progressed. A performance rating factor of 100 percent was used as a fair judgment of the worker's speed. The decision was based on the analyst's observations of the learning curve and her own past professional experience with workers involved in the task of sandwich production. Rest periods of fifteen minutes were observed during each four-hour period of work, eliminating the need for determining fatigue and personal allowances.

Using the formula recommended by Barnes (1968), each element was timed until a confidence level of ± 5 percent or less was obtained.

$$\sigma = \sqrt{\frac{\Sigma x_i^2}{N} - \bar{x}^2}.$$

After a ± 5 percent confidence level had been attained, normal and standard values were developed for each element.

$$\text{Normal time} = \text{selected time} \times \frac{\text{rating in percent}}{100}$$

Standard time = normal time + (normal time x allowances in percent).

The statistical data were computed using a standard deviation program written for the Olivetti desk computer. Student's "t" formation was used to establish the 95 percent confidence interval for each element. Normal and standard time for each element then was computed using the above formula. Graphs plotted from the elemental times in order of sequence were used to demonstrate a learning curve.

CHAPTER IV

RESULTS AND DISCUSSION

The mean, standard deviation, error, 95 percent confidence interval, selected time, normal time, and standard time were determined for each of the elements in the following discussion. The elements were added to give the total standard time for each task. The raw data collected are presented in Appendix B.

Task One: Placing and Adjusting Roast Beef for Slicing

The task of slicing roast beef was divided into four elements which had definite observable beginning and ending motions. The work area was arranged so that the worker stood in the same spot for all the elements and motions were confined to torso and hand movements. For each element, Student's t Distribution was used to set up a 95 percent confidence interval (C.I.).

Element One. Place Beef on Slicer Carriage. The time for this element began when the worker placed her hands on the roast preparatory to moving it to the slicer and ended as she removed her hands to proceed to the next element. One hundred and fifty-nine trials were conducted to obtain a mean of 0.048 minute (Table I) with a standard deviation of 0.0134 and a standard error of 0.0010. The 95 percent C.I. = $0.046 < u < 0.050$.

Normal time = $0.05 \times \frac{100}{100} = 0.05$

Standard time = 0.05 + 0 = 0.05 of a minute.

TABLE I

ELEMENTAL TIMES DETERMINED FOR THE TASK OF SLICING ROAST BEEF[a]

Elements	μ[b]	σ[c]	Error	Confidence Interval 95% Level	Selected Time	Normal Time	Standard Time
1	0.048	0.0134	0.0010	0.046 < u < 0.050	0.05	0.05	0.05
2	0.036	0.0161	0.0010	0.034 < u < 0.038	0.04	0.04	0.04
3	0.042	0.0145	0.0000	0.042	0.04	0.04	0.04
4	0.048	0.0167	0.0010	0.046 < u < 0.050	0.05	0.05	0.05
Total time for slicing roast beef ----------							0.18

[a] minutes

[b] μ = mean

[c] σ = standard deviation

Element Two. Tighten Holder. Timing for this element began as the worker's hands left the roast beef, moved to and gripped holder and ended when she had tightened it in place to hold the meat secure. Two hundred and fifty-four trials were conducted to obtain a mean of 0.036 minute (Table I) with a standard deviation of 0.0161 and a standard error of 0.0010. The 95 percent C. I. = $0.034 < u < 0.038$.

Normal time = $0.04 \times \frac{100}{100} = 0.04$

Standard time = 0.04 + 0 = 0.04 of a minute.

Element Three. Place Plate Down on Roast Beef. Timing for this element began when the worker's hands moved from the holder to the handle of the plate and ended after she had placed the plate on the meat and released the handle. Two hundred and fifty-two trials were conducted to obtain a mean of 0.042 minute (Table I) with a standard deviation of 0.0145 and a standard error of 0.00. The mean 0.042 minute was accepted as the 95 percent confidence interval.

Normal time = $0.04 \times \frac{100}{100} = 0.04$

Standard time = 0.04 + 0 = 0.04 of a minute.

Element Four. Adjust Dial and Start Slicer. Timing for this element began as the worker's hands left the plate handle and ended when the switch was turned on and the worker's hands were at rest. Two hundred and fifty-four trials were conducted to obtain a mean of 0.048 minute (Table I) with a standard deviation of 0.0167 and a standard error of 0.0010. The 95 percent C.I. = $0.046 < u < 0.050$.

Normal time = $0.05 \times \frac{100}{100} = 0.05$

Standard time = 0.05 + 0 = 0.05 of a minute.

The time involved in collecting the data for the elements comprising this task totaled six hours. As indicated by the learning curves (Appendix C) established for these elements, the task was relatively simple to master in a short period of time.

Task Two: Cleaning Lettuce

The job of cleaning lettuce was divided into three easily identifiable elements. In completing this task it was necessary for the worker to move from left to right at the sink as she cleaned the lettuce. The time involved in moving the entire body was included in the appropriate element. For each element, Student's t Distribution was used to set up a 95 percent confidence interval.

Element One. Core Lettuce. Timing for this element began when the worker picked up the head of lettuce and ended when she had laid the removed core on the drainboard. One hundred and eighty-one trials were observed to yield a mean of 0.128 minute (Table II) with a standard deviation of 0.0509 and a standard error of 0.0037. The 95 percent C.I. = $0.1213 < u < 0.1359$.

Normal time = $0.13 \times \frac{100}{100} = 0.13$

Standard time = 0.13 + 0 = 0.13 of a minute.

Element Two. Wash and Drain Lettuce. Timing for this element began when the worker moved to the right, held the head of lettuce under water and drained the lettuce. One hundred and eighty-one trials were conducted to obtain a mean of 0.095 minute (Table II) with a standard deviation of 0.024 and a standard error of 0.0018. The 95 percent C.I. = $0.091 < u < 0.098$.

Normal time = $0.10 \times \frac{100}{100} = 0.10$

Standard time = 0.10 + 0 = 0.10 of a minute.

TABLE II

ELEMENTAL TIMES COMPOSING CLEANING LETTUCE[a]

Elements	μ[b]	σ[c]	Error	Confidence Interval 95% Level	Selected Time	Normal Time	Standard Time
1	0.1286	0.0509	0.0037	0.122 < u < 0.135	0.13	0.13	0.13
2	0.0953	0.0247	0.0018	0.091 < u < 0.098	0.10	0.10	0.10
3	0.9814	0.3641	0.0271	0.928 < u < 1.034	1.03	1.03	1.03
Total time for cleaning a head of lettuce ----------							1.26

[a] minutes

[b] μ = mean

[c] σ = standard deviation

Element Three. Separate Lettuce Leaves. Timing for this element began when the worker moved to the right, removed leaves from the head, and ended when the last leaf had been separated and placed in the sink. One hundred and eighty-one trials were conducted to obtain a mean of 0.981 minute (Table II) with a standard deviation of 0.364 and a standard error of 0.027. The 95 percent C.I. = $0.928 < u < 1.03$.

Normal time = $1.03 \times \frac{100}{100} = 1.03$

Standard time = 1.03 + 0 = 1.03 of a minute.

The extreme variability existing in this element was attributed in part to the nature of the head of lettuce, i.e., a solid head required more time to separate than a loose head of lettuce. Six hours were involved in collecting the data for this task.

Task Three: Assembling Roast Beef Sandwiches

The task of assembling roast beef sandwiches was divided into eight elements whose beginning and ending points were clearly recognizable to the observer. The work area was arranged to eliminate walking and motions were confined to hands, arms, and torso. For each element, Student's t Distribution was used to set up a 95 percent confidence interval.

Element One. Open Two Packages of Rolls. Timing for this element began when the worker placed her hands on the package and ended when the plastic wrapper had been removed to permit access to the buns. One hundred and sixty-nine trials were conducted to obtain a mean of 0.275 minute (Table III) with a standard deviation of 0.0485 and a standard error of 0.0037. The 95 percent C.I. = $0.268 < u < 0.282$.

TABLE III

ELEMENTAL TIMES COMPRISING THE ASSEMBLING OF 24 ROAST BEEF SANDWICHES[a]

Elements	μ[b]	σ[c]	Error	Confidence Interval 95% Level	Selected Time	Normal Time	Standard Time
1	0.275	0.0485	0.0037	0.268 < u < 0.282	0.28	0.28	0.28
2	0.947	0.0923	0.0049	0.937 < u < 0.957	0.96	0.96	0.96
3	0.558	0.1225	0.0061	0.546 < u < 0.570	0.57	0.57	0.57
4	3.834	0.7187	0.0339	3.767 < u < 3.900	3.90	3.90	3.90
5	0.696	0.1790	0.0090	0.679 < u < 0.714	0.71	0.71	0.71
6	0.406	0.0702	0.0034	0.399 < u < 0.412	0.41	0.41	0.41
7	2.517	0.3789	0.0366	2.445 < u < 2.590	2.59	2.59	2.59
8	0.156	0.0471	0.0035	0.149 < u < 0.160	0.16	0.16	0.16
Total time for assembling 24 sandwiches ----------							9.58

[a] minutes

[b] μ = mean

[c] σ = standard deviation

Normal time = $0.28 \times \frac{100}{100} = 0.28$

Standard time = 0.28 + 0 = 0.28 of a minute.

Element Two. Place Twenty-Four Bun Bottoms on Table. Timing for this element began when the worker picked up the first bun and ended when she placed the packages on the work surface behind her. Three hundred and fifty trials were conducted to obtain a mean of 0.947 minute (Table III) with a standard deviation of 0.0923 and a standard error of 0.0049. The 95 percent C.I. = $0.937 < u < 0.957$.

Norman time = $0.95 \times \frac{100}{100} = 0.96$

Standard time = 0.96 + 0 = 0.96 of a minute.

Element Three. Brush Each Bun with Butter. Timing for this element began as the worker's hand moved toward and grasped butter brush and ended when the brush was returned to the butter container. Four hundred and one trials were observed to obtain a mean of 0.558 minute (Table III) with a standard deviation of 0.1225 and a standard error of 0.0061. The 95 percent C.I. = $0.546 < u < 0.570$.

Normal time = $0.57 \times \frac{100}{100} = 0.57$

Standard time = 0.57 + 0 = 0.57 of a minute.

Element Four. Weigh Two and One-Half Ounces of Roast Beef and Place on Each Bun. Timing for this element began as the worker's hand moved toward the roast beef and ended when every bun had been filled with the weighed meat. Four hundred and forty-nine trials were conducted to obtain a mean of 3.834 minute (Table III) with a standard deviation of 0.7181 and a standard error of 0.0339. The 95 percent C.I. = $3.767 < u < 3.900$.

Normal time = $3.90 \times \frac{100}{100} = 3.90$.

Standard time = 3.90 + 0 = 3.90 of a minute.

Element Five. Top Beef with Lettuce Leaf. Timing for this element began as the worker's hands moved toward the container of lettuce leaves and ended when a lettuce leaf had been placed on each sandwich. Three hundred and ninety-nine trials were observed to obtain a mean of 0.696 minute (Table III) with a standard deviation of 0.1790 and a standard error of 0.0090. The 95 percent C.I. = $0.679 < u < 0.714$.

Normal time = $0.71 \times \frac{100}{100} = 0.71$

Standard time = 0.71 + 0 = 0.71 of a minute.

Element Six. Top with Bun. Timing for this element began as the worker reached to the work surface behind her for the bun tops and ended when every sandwich had been covered with a top. Four hundred and twenty-nine trials were conducted to obtain a mean of 0.406 minute (Table III) with a standard deviation of 0.0702 and a standard error of 0.0034. The 95 percent C.I. = $0.399 < u < 0.412$.

Normal time = $0.41 \times \frac{100}{100} = 0.41$

Standard time = 0.41 + 0 = 0.41 of a minute.

Element Seven. Cut and Pan Twenty-Four Sandwiches. Timing for this element began as the worker reached for the knife and ended when the last cut sandwich had been placed on the tray. One hundred and seven observations were made to obtain a mean of 2.517 minute (Table III) with a standard deviation of 0.3789 and a standard error of 0.0366. The 96 percent C.I. = $2.445 < u < 2.590$.

Normal time = $2.59 \times \frac{100}{100} = 2.59$

Standard time = 2.59 + 0 = 2.59 of a minute.

Element Eight. Cover Sandwiches with Damp Towels. Timing for this element began when the worker reached for the first towel and ended

when the second towel had been released to cover the sandwiches. One hundred and eighty-two observations were made to obtain a mean of 0.156 minute (Table III) with a standard deviation of 0.0471 and a standard error of 0.0035. The 95 percent C.I. = $0.149 < u < 0.160$.

Normal time = $0.16 \times \frac{100}{100} = 0.16$

Standard time = 0.16 + 0 = 0.16 of a minute.

A total of 69 hours was involved in collecting the data for the elements composing this task. For all except three of the elements, the learning curves indicated that the task is a complicated one in which to become proficient. Sample graphs of learning curves are in Appendix C.

The learning curve (Appendix C) revealed a slow and erratic rate of performance with a speeding up and finally a leveling off of time as related to units produced. In addition to establishing standard elemental times, this study emphasized the time pattern of learning as related to a manual task. It was observed from this study that procedures involved in establishing standard times used by industrial engineers, as illustrated by Niebel (1972), apply equally well to a food service worker.

Standard times serve as a guide to management as to the amount of work one can expect to be produced in a specified period of time. In a food service operation with a similar work station area, the times may be applied to determine the efficiency and effectiveness of the worker engaged in these tasks. The elemental times serve as a means of analyzing each motion involved in the task to reveal where work methods need improvement.

Elemental times may be applied to tasks utilizing the same work motions, and form of meat produced under the same conditions as suggested by Beach et al., 1969. They may be used to synthesize total production times for a task. Simulated production times will enable management to adjust the labor force to meet needs attributable to variations in the work load.

Food service industries such as central kitchens and vending companies will find these established standard times a valuable tool. Through the application of the results of this study, food service operations engaged in the production of large quantities of sandwiches daily may realize substantial savings in time and labor costs. Industries using the horizontal method of food production may use these standard times to set up a wage incentive plan as one method of coping with labor costs, which is in agreement with Blaker, 1970.

Food service operations are finding it increasingly difficult to survive due to costs. There is a need to establish standard elemental times for basic work motions which can be used throughout the industry. Standard elemental data are predicted to provide the manual method and time value for almost any common element of work (Stukey, 1964). Research involving machine and man hours, shutdowns and delays is clearly indicated as the industry moves more rapidly toward mechanization and automation.

Evidence from the literature (Christensen, 1958) indicates that study of elemental times may serve as a guide for production improvement. The results of this study also indicate that elemental times could be

used to evaluate present and proposed work methods, standardize procedures and techniques, predict production times, and effectively schedule personnel and equipment.

CHAPTER V

SUMMARY

Standard elemental times for the procedure used in making roast beef sandwiches in units of twenty-four were developed. The tasks of slicing beef, cleaning lettuce, and assembling the roast beef sandwiches were studied. Each task was divided into elements and each element was timed under similar conditions with the same worker using the continuous method of stop-watch timing.

Sequential time data were plotted graphically to illustrate the learning curve demonstrated in the elements. A performance rating factor of 100 percent was used as a fair judgment of the worker's speed. Rest periods of fifteen minutes were observed during each four-hour work period. This eliminated the need for consideration of personal and fatigue allowances.

A 95 percent confidence interval was used as the basis for determination of standard times for each element. Through the additivity of the elemental times, total task time of 0.18 minutes was established for placing and adjusting roast beef for slicing; 1.26 minutes for cleaning a head of lettuce; and 9.58 minutes for assembling twenty-four roast beef sandwiches.

Using elemental times determined in the study, it could be possible for managers to evaluate present and proposed work methods, standardize procedures and techniques, predict production times, and effectively schedule personnel and equipment.

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APPENDICES

APPENDIX A

OBSERVATION SHEET

Operation: Slicing Roast Beef **Date:**

Operator's Name: **Beginning Time:**

Experience on Job: **Time Finished:**

Observer's Name: **Elapsed Time:**

Elements	Units Finished / Actual Time Per 100	1	2	3	4	5	6	7	8	9	10
1. Place beef roast on slicer carriage	T										
	R										
2. Tighten holder against roast	T										
	R										
3. Place plate down on meat	T										
	R										
4. Adjust dial and start slicing	T										
	R										
	T										
	R										

Selected Time	Rating	Normal Time	Total Allowances	Standard Time

Sketch of Work Area

Equipment

OBSERVATION SHEET

Operation: Cleaning Iceberg Lettuce

Date:

Operator's Name:

Beginning Time

Experience on Job:

Time Finished

Observer's Name:

Elapsed Time

Elements		Units Finished 1	2	3	4	Actual Time Per unit 5	6	7	8	9	10
1. Remove core by hitting against drainboard	T										
	R										
2. Wash lettuce in water to clean head	T										
	R										
3. Separate leaves	T										
	R										
	T										
	R										
	T										
	R										

Selected Time	Rating	Normal Time	Total Allowances	Standard Time

Sketch of Work Area:

Equipment

OBSERVATION SHEET

Operation: Making Roast Beef Sandwiches — Date:

Operator's Name: — Beginning Time

Experience on Job: — Time Finished

Observer's Name — Elapsed Time

Elements		Units Finished 1	2	3	4	5	Actual Time Per unit 6	7	8	9	10
1. Open 2 packages of hamburger rolls	T										
	R										
2. Place 24 bottom halves on table	T										
	R										
3. Brush each bottom of roll with oleo-margarine	T										
	R										
4. Place 2-1/2 ozs. chipped beef on bread	T										
	R										
5. Top with lettuce leaf	T										
	R										
6. Top with roll	T										
	R										
7. Cut 24 sandwiches in half and place 24 sandwiches in pan	T										
	R										
8. Cover sandwiches with damp towels	T										
	R										

Selected Time	Rating	Normal Time	Total Allowance	Standard Time

Sketch of Work Area:

Equipment:

APPENDIX B

TABLE IV

TIME DATA[a] FOR PLACING BEEF ON SLICER

Trial Nos. 1-32	Trial Nos. 33-64	Trial Nos. 65-96	Trial Nos. 97-128	Trial Nos. 129-159
2	5	5	3	5
5	5	10	5	4
4	4	5	4	4
3	4	5	4	4
4	5	5	4	8
4	4	4	4	5
4	4	5	4	6
4	4	4	4	5
3	7	4	5	7
4	6	6	5	7
5	6	7	4	9
5	6	5	4	6
4	5	4	4	5
4	7	4	4	4
4	7	5	4	4
4	5	5	5	4
4	6	4	4	4
4	5	4	4	4
4	4	4	4	4
5	4	3	5	7
5	5	4	8	5
5	11	12	5	6
5	7	5	5	5
4	6	5	5	4
4	6	5	5	4
3	5	5	4	4
4	6	5	4	5
5	5	5	5	4
5	4	5	6	4
5	5	4	5	3
5	4	4	4	6
4	4	4	4	

[a]Measured in units of one hundredths of a minute.

TABLE V

TIME DATA[a] FOR TIGHTENING HOLDER

Trial Nos. 1-32	Trial Nos. 33-64	Trial Nos. 65-96	Trial Nos. 96-128
8	6	5	3
2	5	4	3
5	5	5	2
4	3	5	3
4	4	5	4
4	3	3	3
5	3	4	9
7	3	8	4
4	5	5	4
7	6	5	4
5	6	4	4
6	6	4	3
6	5	4	3
6	5	5	3
6	5	5	5
4	4	3	3
6	5	4	3
6	5	4	6
5	5	6	7
5	3	1	4
7	5	9	4
6	5	7	3
6	8	6	4
5	5	6	4
4	6	5	3
2	6	3	3
4	4	3	5
6	7	3	3
5	5	3	2
5	5	3	4
5	4	6	3
6	10	4	3

TABLE V (continued)

Trial Nos. 129-160	Trial Nos. 161-192	Trial Nos. 193-224	Trial Nos. 225-254
3	3	2	2
4	3	2	2
5	4	3	2
5	3	2	2
6	4	2	2
4	2	2	2
8	3	2	2
5	4	2	2
3	3	2	2
3	3	2	2
3	5	3	2
4	4	2	2
3	3	2	3
3	3	2	3
3	3	2	2
3	3	3	2
3	3	3	2
3	2	2	2
2	3	2	2
3	2	2	3
2	2	2	2
2	3	2	3
2	4	2	2
3	2	3	2
2	2	3	2
4	2	3	2
3	3	2	2
4	2	2	2
3	2	2	2
6	3	3	2
5	2	2	
4	2	2	

[a]Measured in units of one hundredths of a minute.

TABLE VI

TIME DATA[a] FOR PLACING PLATE DOWN ON MEAT

Trial Nos. 1-32	Trial Nos. 33-64	Trial Nos. 65-96	Trial Nos. 97-128
8	4	6	4
2	5	3	4
2	5	4	5
4	4	1	4
6	7	5	5
7	7	2	4
6	5	6	4
7	5	4	3
7	8	4	4
9	6	6	4
10	7	3	5
4	5	7	5
4	6	3	4
1	5	4	4
6	6	4	4
4	5	3	7
5	5	5	4
3	7	4	4
6	5	5	4
5	6	6	5
8	5	6	4
5	4	6	4
4	4	4	4
7	4	4	3
5	6	7	4
6	6	4	4
6	6	4	3
10	4	4	4
5	5	3	3
3	5	4	4
3	3	4	4
2	3	4	3

TABLE VI (continued)

Trial Nos. 129-160	Trial Nos. 161-192	Trial Nos. 193-224	Trial Nos. 225-252
4	3	4	3
8	3	3	4
5	4	4	3
4	4	3	4
5	5	4	3
3	4	4	4
6	3	4	3
4	4	4	4
5	4	3	3
4	5	3	4
3	3	4	5
4	4	4	4
2	4	4	4
4	4	3	3
3	3	3	3
3	3	3	3
5	5	3	3
3	3	3	4
3	3	3	3
5	3	4	3
5	3	3	2
5	3	4	3
6	4	3	3
5	4	3	3
5	3	3	3
4	4	4	3
11	4	3	3
4	3	3	2
4	4	3	
3	5	3	
4	4	3	
5	4	3	

[a]Measured in units of one hundredths of a minute.

TABLE VII

TIME DATA[a] FOR SETTING DIAL AND STARTING SLICER

Trial Nos. 1-32	Trial Nos. 33-64	Trial Nos. 65-96	Trial Nos. 97-128
10	8	4	5
19	5	6	5
8	5	4	4
5	9	6	6
4	5	6	5
7	5	11	5
8	4	5	4
10	5	6	5
3	4	4	4
4	5	5	7
4	4	6	5
6	7	4	6
5	3	6	5
6	6	5	6
5	6	6	4
4	5	5	5
6	6	5	4
7	4	6	6
6	6	5	5
7	9	6	5
4	5	5	4
5	6	5	6
5	6	4	6
5	6	4	4
5	4	4	5
7	5	4	5
5	4	5	5
2	4	4	5
6	5	5	5
6	5	4	4
10	6	5	5
9	6	4	4

TABLE VII (continued)

Trial Nos. 129-160	Trial Nos. 161-192	Trial Nos. 193-224	Trial Nos. 225-254
4	2	4	3
4	3	4	3
6	3	4	4
6	4	4	3
6	5	5	4
6	5	4	4
7	4	4	4
4	5	4	3
4	4	5	4
5	4	4	4
5	6	3	4
4	6	5	4
4	4	5	5
5	3	5	3
4	4	4	4
4	5	4	5
4	4	4	5
7	5	4	4
10	3	3	4
7	4	4	3
4	4	3	4
3	3	3	3
6	4	4	4
5	5	4	4
4	3	3	4
4	3	3	3
5	4	4	3
4	4	4	4
3	5	3	3
5	4	4	5
5	4	3	
4	3	3	

[a]Measured in units of one hundredths of a minute.

TABLE VIII

TIME DATA[a] FOR REMOVING LETTUCE CORE

Trial Nos. 1-37	Trial Nos. 38-74	Trial Nos. 75-111	Trial Nos. 112-148	Trial Nos. 149-181
20	10	12	11	8
29	11	20	12	10
15	8	12	21	9
22	8	12	12	9
19	10	11	13	9
16	11	13	10	15
13	15	8	14	9
12	12	10	9	12
13	10	12	16	11
13	13	10	15	12
12	19	10	9	13
12	18	10	13	13
28	22	11	24	11
45	15	11	11	9
15	12	9	10	12
17	10	13	11	10
11	15	10	10	12
35	21	11	13	10
21	11	11	9	12
14	25	10	19	10
15	11	11	13	14
15	21	12	10	13
25	10	11	10	10
12	10	10	9	10
6	11	15	14	9
10	17	16	10	10
15	17	11	8	14
10	32	11	13	10
12	18	14	9	10
10	16	12	10	10
10	10	12	11	11
10	11	12	9	10
12	12	11	9	8
11	20	13	9	
9	7	18	18	
9	9	12	9	
11	8	13	10	

[a]Measured in units of one hundredths of a minute.

TABLE IX

TIME DATA[a] FOR WASHING A HEAD OF LETTUCE

Trial Nos. 1-37	Trial Nos. 38-74	Trial Nos. 75-111	Trial Nos. 112-148	Trial Nos. 149-181
18	7	10	9	9
9	7	4	10	10
14	9	10	9	9
13	7	11	9	10
11	10	9	9	8
5	8	11	8	10
9	8	13	12	9
13	6	9	9	11
13	11	12	20	8
13	12	7	13	10
13	8	9	10	11
13	7	9	13	10
12	6	10	11	10
14	7	7	8	10
13	6	11	10	9
9	19	11	11	11
14	7	11	13	10
12	9	10	8	14
13	8	11	10	8
15	4	9	10	8
9	7	11	8	10
10	9	10	11	10
13	7	8	10	8
10	6	11	13	8
11	7	8	10	8
9	7	8	8	10
7	7	9	10	9
5	5	10	9	9
8	3	9	7	11
10	7	9	11	8
10	8	8	11	8
8	9	9	6	10
7	9	8	12	7
7	9	9	11	
7	11	9	10	
7	10	9	9	
6	13	9	9	

[a]Measured in units of one dundredths of a minute

TABLE X

TIME DATA[a] FOR SEPARATING LETTUCE LEAVES

Trial Nos. 1-37	Trial Nos. 38-74	Trial Nos. 75-111	Trial Nos. 112-148	Trial Nos. 149-181
207	94	94	38	94
134	81	169	42	131
174	84	86	93	85
86	76	108	74	103
110	57	49	53	93
219	132	120	36	62
117	66	70	51	74
171	107	91	54	87
134	130	102	194	119
122	146	66	238	73
83	61	85	177	71
73	94	78	153	73
192	143	108	158	73
129	112	65	87	70
101	91	72	162	113
102	115	74	138	83
161	120	105	121	62
62	79	76	115	116
39	123	70	98	48
50	166	75	103	97
50	96	75	105	85
133	90	58	145	66
65	92	66	124	46
139	83	80	115	52
102	113	79	115	81
88	92	96	55	70
128	113	77	81	78
87	108	69	122	71
92	86	72	110	83
162	74	63	103	52
123	162	90	88	72
114	135	86	62	70
123	150	54	107	54
86	109	48	108	
99	162	82	107	
74	83	65	109	
104	130	84	120	

[a]Measured in units of one hundredths of a minute.

TABLE XI

TIME DATA[a] FOR OPENING TWO PACKAGES OF ROLLS

Trial Nos. 1-34	Trial Nos. 35-68	Trial Nos. 69-103	Trial Nos. 103-136	Trial Nos. 137-169
17	29	22	36	28
20	24	26	32	29
19	28	24	34	26
17	27	26	29	27
20	27	25	32	24
25	26	26	32	26
29	24	23	31	26
29	25	24	41	32
25	22	25	38	29
21	24	26	44	28
28	28	23	35	26
23	25	25	33	25
35	25	24	30	25
19	24	22	31	26
25	23	30	31	26
34	27	26	38	25
35	24	25	40	30
28	25	39	38	31
18	25	35	28	26
39	27	28	34	25
27	25	26	29	26
34	22	26	32	26
24	23	30	29	25
25	30	24	33	23
27	23	24	32	24
21	28	29	29	25
28	29	35	32	26
25	39	27	28	24
26	32	32	29	24
22	32	29	32	26
23	25	28	35	22
25	29	26	37	23
24	32	28	22	24
23	26	35	26	

[a]Measured in units of one hundredths of a minute.

TABLE XII

TIME DATA[a] FOR PLACING 24 BOTTOM ROLL HALVES ON TABLE

Trial Nos. 1-35	Trial Nos. 36-70	Trial Nos. 71-105	Trial Nos. 106-140	Trial Nos. 141-175
91	77	96	100	120
102	77	95	102	88
71	89	74	92	100
97	99	95	111	102
105	100	115	100	99
85	94	95	137	103
96	101	97	127	118
96	83	91	127	112
93	92	84	109	103
84	110	85	115	100
83	96	91	118	104
112	97	95	120	119
104	98	94	125	100
82	100	96	114	115
99	88	106	85	98
100	85	91	94	92
114	102	94	85	93
107	90	84	95	93
99	98	94	97	97
127	91	105	100	87
105	102	96	95	95
101	96	101	81	98
76	94	104	87	86
82	103	100	88	94
89	96	105	89	96
75	89	106	94	104
97	94	93	100	99
95	102	96	93	105
98	93	99	100	96
73	93	97	99	98
88	91	97	103	100
96	97	96	107	106
73	95	94	96	105
64	93	96	120	93
86	93	95	103	95

TABLE XII (continued)

Trial Nos. 176-210	Trial Nos. 211-245	Trial Nos. 246-280	Trial Nos. 281-315	Trial Nos. 316-350
85	101	94	91	96
87	102	88	88	95
97	100	86	95	97
88	101	90	91	99
97	103	85	90	98
99	103	85	91	99
90	106	89	96	98
95	79	85	90	95
99	88	84	86	87
94	92	85	89	94
101	94	86	92	99
89	89	84	83	100
95	99	84	93	95
90	94	89	94	96
97	96	83	96	93
99	98	87	98	85
104	87	82	96	92
98	73	84	95	91
95	77	85	92	96
103	80	85	94	90
99	87	85	95	94
96	89	87	99	96
98	91	85	92	99
92	89	86	92	96
90	92	84	90	95
85	95	86	90	79
92	92	86	98	84
91	100	85	88	90
90	93	84	94	102
92	96	86	94	98
90	94	85	94	97
98	86	90	95	100
99	88	85	98	101
106	96	86	96	96
100	97	87	95	97

[a]Measured in units of one hundredths of a minute.

TABLE XIII

TIME DATA[a] FOR BRUSHING EACH HALF WITH OLEOMARGARINE

Trial Nos. 1-34	Trial Nos. 35-68	Trial Nos. 68-102	Trial Nos. 103-136	Trial Nos. 137-170	Trial Nos. 171-204
97	56	37	41	45	49
93	50	49	42	49	55
89	64	41	75	35	56
97	49	42	54	46	55
84	49	51	41	47	53
79	62	45	51	53	50
96	71	47	42	52	57
82	74	49	42	50	57
88	49	60	51	57	62
79	58	65	39	62	72
104	91	58	45	62	69
80	68	51	47	79	62
82	69	41	41	64	58
85	74	42	47	69	74
91	97	52	54	60	62
87	51	43	39	58	53
85	60	44	44	61	62
82	60	53	41	54	74
83	74	45	41	61	66
81	66	34	42	77	62
95	61	62	46	62	63
87	66	46	38	49	51
60	72	37	43	61	63
65	60	35	42	50	51
60	79	38	46	61	62
64	46	32	39	50	50
68	45	47	36	59	55
58	72	40	39	59	67
72	74	42	35	61	58
78	75	36	36	63	55
64	53	42	44	59	56
68	24	42	47	55	68
58	45	38	40	48	75
44	45	46	49	54	76

TABLE XIII (continued

Trial Nos. 205-238	Trial Nos. 239-272	Trial Nos. 273-306	Trial Nos. 307-340	Trial Nos. 341-374	Trial Nos. 375-401
70	54	55	46	56	54
71	47	58	46	54	59
62	48	54	48	44	60
59	51	52	50	53	59
66	46	59	48	46	56
53	45	55	45	67	64
53	45	54	46	52	66
58	50	54	50	54	54
60	47	59	49	50	62
56	44	53	48	54	62
60	51	59	52	55	70
49	54	46	50	53	68
48	48	44	50	53	53
58	53	47	65	53	61
53	54	42	58	58	60
43	50	54	68	61	59
48	54	56	63	60	60
54	49	56	61	55	48
40	51	51	61	53	55
45	48	52	56	50	47
51	41	50	46	52	45
51	37	55	52	56	72
49	53	50	44	56	47
52	47	56	50	55	47
47	55	49	49	53	61
59	47	46	53	53	57
55	41	50	56	54	64
53	53	48	56	55	
58	41	54	57	59	
57	53	52	50	56	
56	46	55	51	54	
60	60	55	63	50	
53	56	53	79	66	
49	59	50	61	55	

[a]Measured in units of one hundredths of a minute.

TABLE XIV

TIME DATA[a] FOR WEIGHING AND PLACING TWO AND ONE-HALF OUNCES OF BEEF ON ROLL

Trial Nos. 1-38	Trial Nos. 39-76	Trial Nos. 77-114	Trial Nos. 115-152	Trial Nos. 153-190	Trial Nos. 191-228
515	538	283	281	356	339
502	518	304	274	399	363
608	496	308	275	380	370
501	471	290	253	398	386
507	432	278	287	341	367
495	475	321	259	364	381
430	443	285	348	400	341
545	501	256	288	410	446
520	450	334	274	370	451
585	435	256	278	418	418
610	552	244	263	382	378
533	623	292	285	425	415
582	787	284	292	386	424
554	460	251	254	375	475
573	523	229	252	434	435
512	456	255	263	461	428
457	512	269	259	403	370
500	486	296	301	423	386
515	445	265	292	425	368
486	511	250	276	371	384
467	482	314	280	383	353
403	500	333	283	403	398
480	446	252	265	428	397
475	454	251	267	311	451
496	505	276	334	383	425
525	427	287	368	373	366
497	394	274	369	408	403
487	451	248	365	364	378
534	488	505	425	384	314
547	421	283	383	421	378
455	456	300	367	526	395
410	400	324	409	497	416
385	348	314	370	412	419
461	380	291	403	433	370
398	295	320	421	400	367
503	302	313	399	391	350
453	296	287	315	389	374
503	320	277	384	423	381

TABLE XIV (continued)

Trial Nos. 229-266	Trial Nos. 267-304	Trial Nos. 305-342	Trial Nos. 343-380	Trial Nos. 381-418	Trial Nos. 419-449
424	375	425	400	395	390
421	372	341	398	407	377
386	410	392	406	379	361
418	374	386	395	397	356
400	409	335	357	382	361
410	367	340	399	446	365
416	335	355	399	412	365
387	358	326	372	405	358
361	349	424	362	403	361
358	335	450	374	380	360
422	366	463	432	364	362
414	355	457	380	381	450
419	368	453	411	355	361
422	382	416	389	357	363
416	361	460	425	366	379
419	366	390	426	373	365
358	401	412	417	391	369
414	373	361	368	370	361
428	335	319	332	394	360
422	328	353	358	366	373
460	332	328	376	368	364
444	346	391	338	349	367
427	347	373	376	357	392
413	330	388	347	387	370
386	350	343	341	356	407
390	340	298	360	354	410
378	346	355	379	325	365
350	340	327	355	317	392
322	324	398	440	340	361
302	338	369	499	353	384
304	344	365	435	367	357
370	328	356	438	359	
281	353	372	401	356	
314	351	351	438	360	
304	375	344	360	387	
259	370	361	388	326	
242	349	299	362	325	
254	344	398	385	382	

[a]Measured in units of one hundredths of a minute.

TABLE XV

TIME DATA[a] FOR TOPPING WITH LETTUCE LEAF

Trial Nos. 1-40	Trial Nos. 41-80	Trial Nos. 81-120	Trial Nos. 121-160	Trial Nos. 161-200
122	101	79	69	71
125	60	99	60	71
112	69	83	57	62
106	103	90	61	63
99	100	98	74	61
127	113	114	66	75
98	110	71	66	73
121	102	81	60	80
121	100	79	62	60
114	72	101	51	86
131	90	93	59	100
117	92	79	54	71
123	87	76	73	83
122	80	97	45	67
127	71	86	57	72
126	86	66	53	63
110	88	81	79	88
41	71	95	71	74
118	74	67	83	73
126	82	75	86	80
115	58	80	79	65
89	66	72	72	70
118	62	69	72	90
103	63	75	69	70
93	65	51	65	66
92	61	55	57	64
97	73	77	72	67
108	65	72	75	72
105	66	78	64	73
139	65	73	66	63
90	50	69	61	90
94	56	65	71	74
102	61	67	64	73
72	61	70	59	81
94	46	50	46	72
97	47	57	57	71
106	56	53	55	61
90	61	53	59	72
101	58	56	51	68
97	97	60	57	59

TABLE XV (continued)

Trial Nos. 201-240	Trial Nos. 241-280	Trial Nos. 281-320	Trial Nos. 321-360	Trial Nos. 361-399
59	63	53	52	61
79	61	63	53	66
73	56	54	56	67
67	55	52	52	70
69	57	56	45	56
73	61	61	43	70
67	55	55	50	59
63	56	62	55	67
75	57	50	51	65
62	55	57	59	52
71	52	67	55	60
81	70	53	63	64
71	49	61	62	60
88	60	55	63	61
74	58	54	61	65
62	49	48	68	53
62	50	55	60	60
67	54	60	65	59
60	55	68	55	61
61	50	51	55	66
64	73	61	55	63
56	62	61	53	58
58	61	71	54	62
57	69	60	50	64
66	61	59	52	66
60	68	58	52	60
51	60	50	55	65
61	56	50	68	60
68	58	51	68	63
64	64	58	68	61
65	78	62	63	60
57	63	59	63	70
69	71	62	65	56
73	56	56	62	62
72	64	57	61	52
61	63	55	63	63
69	60	61	65	61
58	70	59	60	68
62	57	63	55	65
59	58	61	55	

[a]Measured in units of one hundredths of a minute.

TABLE XVI

TIME DATA[a] FOR TOPPING WITH UPPER ROLL HALF

Trial Nos. 1-36	Trial Nos. 37-72	Trial Nos. 73-108	Trial Nos. 109-144	Trial Nos. 145-180	Trial Nos. 181-216
81	51	35	35	36	56
87	37	36	35	41	51
76	61	32	39	43	45
63	52	33	37	42	44
52	53	33	38	47	40
51	46	32	35	41	45
54	49	31	33	40	41
58	44	47	46	43	47
59	43	37	38	36	48
64	44	46	34	36	40
73	43	42	33	36	38
60	38	47	31	47	47
53	39	55	33	39	46
45	40	47	32	42	43
40	41	44	33	38	45
40	41	46	35	41	45
42	38	45	40	40	39
51	39	40	33	37	35
54	32	41	35	49	52
57	31	39	41	44	45
57	39	52	35	44	47
47	36	45	32	45	47
37	41	54	31	38	41
37	36	41	31	41	52
50	41	45	37	40	40
43	33	45	34	44	38
38	32	42	27	42	46
36	40	46	50	48	43
53	38	48	44	44	41
58	37	37	41	39	45
47	40	37	39	45	50
41	31	34	39	48	45
42	36	35	50	42	55
42	36	35	50	42	55
58	35	33	43	47	47
46	33	36	45	46	41
47	34	32	45	42	35

TABLE XVI (continued)

Trial Nos. 217-252	Trial Nos. 253-288	Trial Nos. 289-324	Trial Nos. 325-360	Trial Nos. 361-396	Trial Nos. 397-429
42	39	35	31	38	40
41	34	43	39	39	41
40	41	34	39	35	35
43	33	33	33	37	35
40	35	33	39	42	43
38	38	35	42	39	42
43	31	35	36	39	38
37	36	35	34	47	44
45	38	33	38	41	44
33	38	35	39	46	37
40	40	36	40	42	34
40	41	39	37	39	34
38	42	37	38	40	36
37	41	39	41	40	39
41	35	41	44	38	39
32	35	39	40	36	43
48	42	36	39	37	37
37	40	38	38	36	41
42	41	32	35	42	41
39	40	34	39	43	37
35	48	39	39	37	37
34	34	44	44	41	38
31	39	39	38	33	39
38	42	36	41	42	37
43	33	38	42	38	38
45	42	36	38	35	37
36	43	39	46	39	39
40	40	36	42	32	39
37	42	31	42	41	41
38	37	42	41	40	39
32	41	32	42	41	35
33	35	34	37	38	40
33	36	37	38	41	39
32	37	35	37	39	
36	41	38	42	30	
39	35	33	39	37	

[a]Measured in units of one hundredths of a minute.

TABLE XVII

TIME DATA[a] FOR CUTTING AND PANNING 24 SANDWICHES

Trial Nos. 1-27	Trial Nos. 28-54	Trial Nos. 55-81	Trial Nos. 82-107
284	249	284	182
313	259	297	168
282	277	300	171
312	265	263	150
278	219	261	189
311	231	261	188
260	259	265	190
275	252	265	186
256	311	274	249
268	297	260	244
303	260	277	220
289	290	245	222
302	272	255	257
293	270	234	256
291	234	234	259
242	248	218	257
254	279	198	247
285	287	221	255
276	272	184	257
274	264	205	253
277	299	189	259
249	296	204	234
252	295	186	222
258	297	184	236
251	292	188	248
239	300	170	220
256	295	201	

[a]Measured in units of one hundredths of a minute.

TABLE XVIII

TIME DATA[a] FOR COVERING SANDWICHES WITH DAMP TOWELS

Trial Nos. 1-37	Trial Nos. 38-74	Trial Nos. 75-111	Trial Nos. 112-148	Trial Nos. 149-182
32	20	13	12	12
30	16	14	11	14
33	19	15	10	12
17	14	13	12	12
25	20	13	11	12
26	19	13	14	11
29	19	15	11	13
30	20	13	12	14
29	18	10	11	14
18	20	13	18	13
22	21	14	15	14
23	18	11	14	12
26	20	14	11	16
17	18	12	12	18
22	20	12	11	16
19	17	12	12	13
22	17	13	12	17
24	15	13	13	17
26	15	13	16	13
21	13	13	12	13
26	17	12	12	14
19	13	13	10	12
23	16	14	12	18
21	17	20	14	13
20	16	11	11	13
15	21	11	13	14
18	23	19	11	13
16	13	12	13	11
16	12	10	16	14
14	17	18	14	12
18	14	12	14	15
16	15	11	13	14
13	14	12	13	17
14	17	10	14	11
16	16	15	11	
30	17	12	10	
17	13	11	13	

[a]Measured in units of one hundredths of a minute.

APPENDIX C

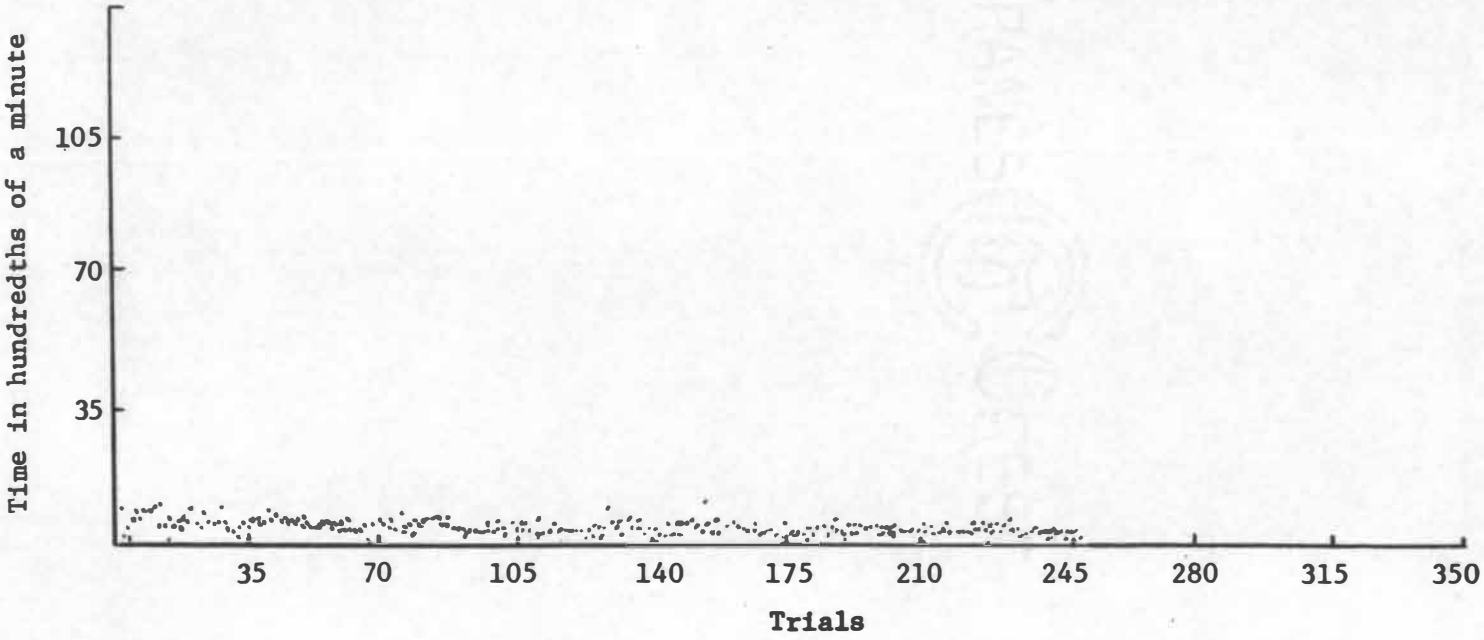

Figure 4. Time data for placing plate down on meat.

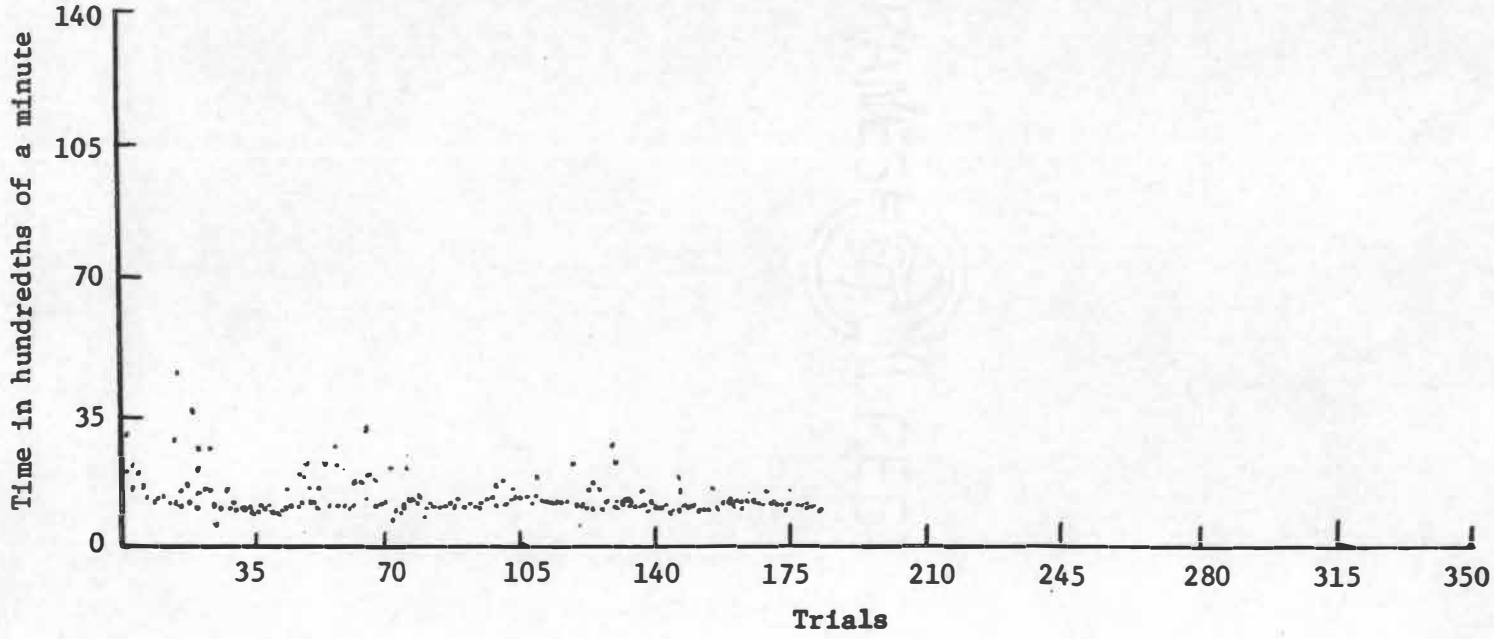

Figure 5. Time data for removing lettuce core.

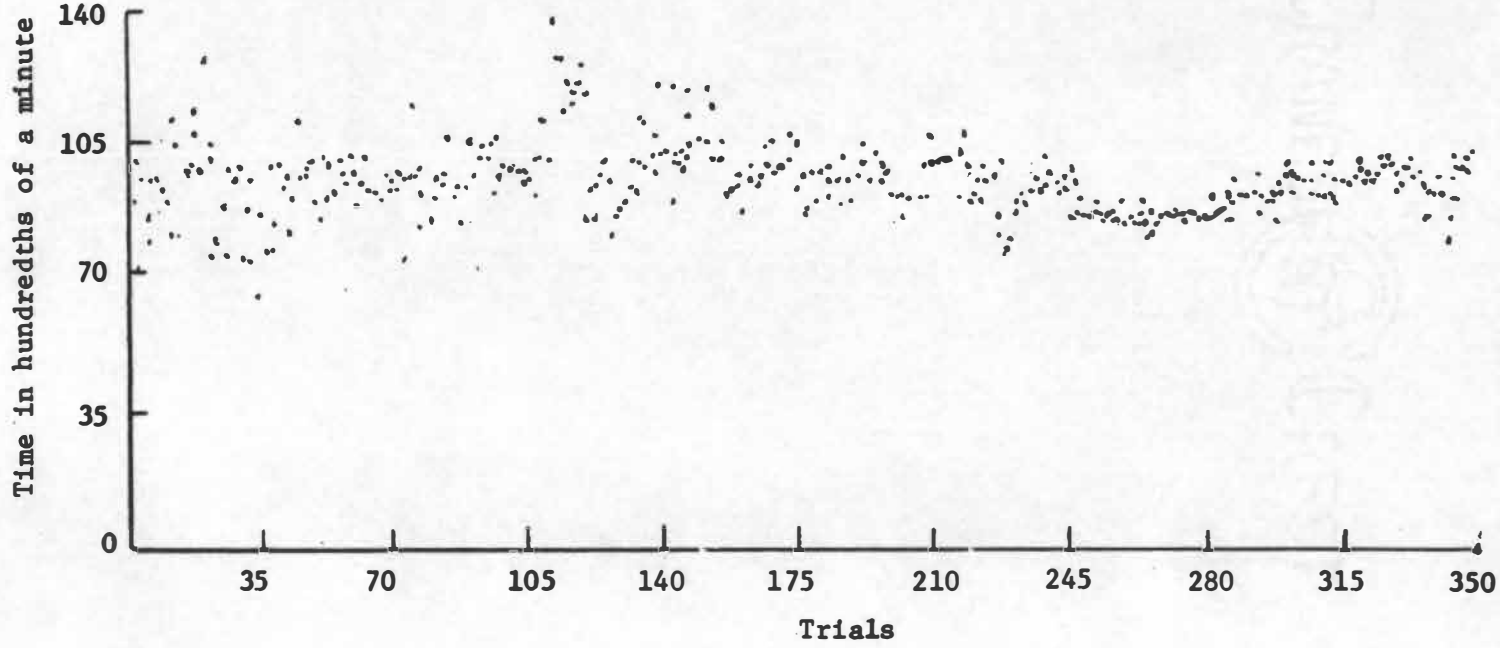

Figure 6. Time data for placing 24 bottom roll halves on table.

VITA

Nadine Emilia Smith was born in Seattle, Washington, on June 28, 1929. She attended schools in Maryland and Virginia and was graduated from high school in 1946. She received a Bachelor of Science degree in Institutional Management in 1950, at Madison College, Harrisonburg, Virginia. In 1951, she completed the dietetic intern program at Albany Hospital, Albany, New York, and was accepted as a member in the American Dietetic Association.

Since that time she has had varied professional experience as a dietitian in hospitals, commercial food operation, and the school lunch program.

She entered the Graduate School at The University of Tennessee, Knoxville, in June, 1969, and received the Master of Science degree with a major in Institutional Administration in June, 1972. She is a member of the American Dietetic Association, The American School Food Service Association, and Zeta Tau Alpha.